Macrosegregation and Grain Formation Caused by Convection Associated with Directional Solidification through Cross-Section Increase.

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Abstract: Cylindrical Al-7 wt% Si, Al-19 wt% Cu and Pb-6 wt% Sb alloy samples were directionally solidified (DS) with liquid above, solid below, and gravity pointing down, in graphite crucibles having an abrupt cross-sectional increase. These alloys have similar solidification shrinkage but are expected to have different degrees of thermosolutal convection during solidification. Microstructures in the DS samples in the vicinity of the section change have been studied in order to examine the effect of convection associated with the combined influence of thermosolutal effects and solidification shrinkage. Extensive radial and axial macrosegregation associated with cross-section change is observed. It also appears that steepling and local primary α-phase remelting resulting from convection are responsible for stray grain formation at the reentrant corners. Preliminary results from a numerical model, which includes solidification shrinkage and thermosolutal convection in the mushy zone, indicate that these regions are prone to solutal remelting of dendrites.